I'M SPEAKING AT

Brightcon 2026

Collaboration: Mixing Tools, Data & People

September 21–25, 2026

Aalborg University & Online

Scan to register online (by Sep 18 2026)





A Collaborative Systematic Review of LCA data formats: Benefits, Limitations, and Silos

Robin Dethienne

Université catholique de Louvain

25 September – 2pm

Your LCA data format's limitations don't show up until it's too late — and expensive to fix.

Organized by DÉPART DE SENTIER, AALBORG UNIVERSITY

Sponsored by One Click LCA, 2-0 LCA, ecoinvent



Context

1996

Life Cycle Inventory Data:

Development of a Common Format

[1]Axel Singhofen, [2]Christine R. Hemming, [3]Bo P. Weidema*, [4]Laurent Grisel*, [5]Rolf Bretz, [6]Bea De Smet, [7]David Russell

2026

Global LCA Data Access

+100 000 dataset
+30 data providers
+5 data formats
One conversion tool

GreenDelta / **olca-converter**

- Avoiding interoperability silo
- Prioritizing software development
- Maximizing the visibility of existing tools
- Showing benefits and limitations of data formats

Ecosystem

- LCIA calculator
- Database
- Activity
- Data format
- Schema
- Nomenclature

- Converter tool
- Modeling principles
- ...
- Platform
- Network
- Location
- Sector
- ...

Questions



Avoiding interoperability silo

« Given the sector and location of the activity I am doing the LCA for, which LCIA calculator and export data format should I choose for a performant* interoperability ? »

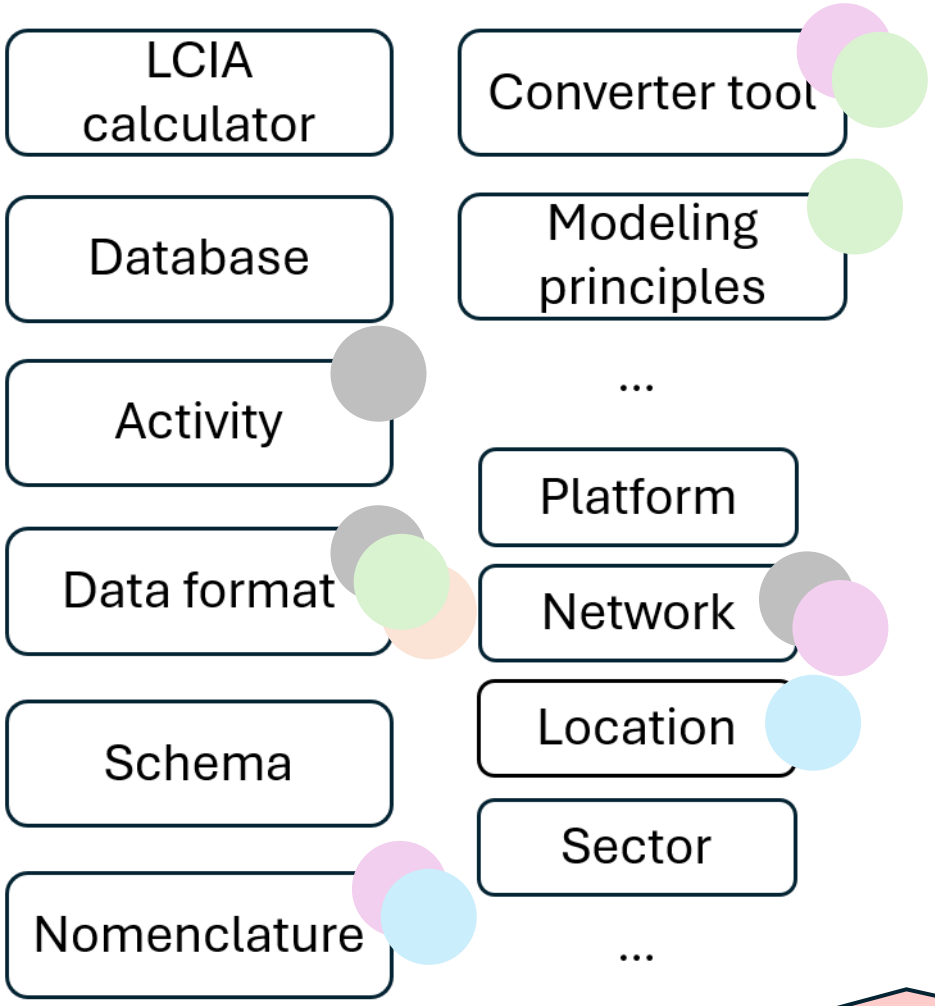


Prioritizing software development

« Given the sector and location of current users of a tool, which interoperability pathway should we develop first ? »

*performance = avoiding as much data loss as possible with an efficient use of ressource

State of the art

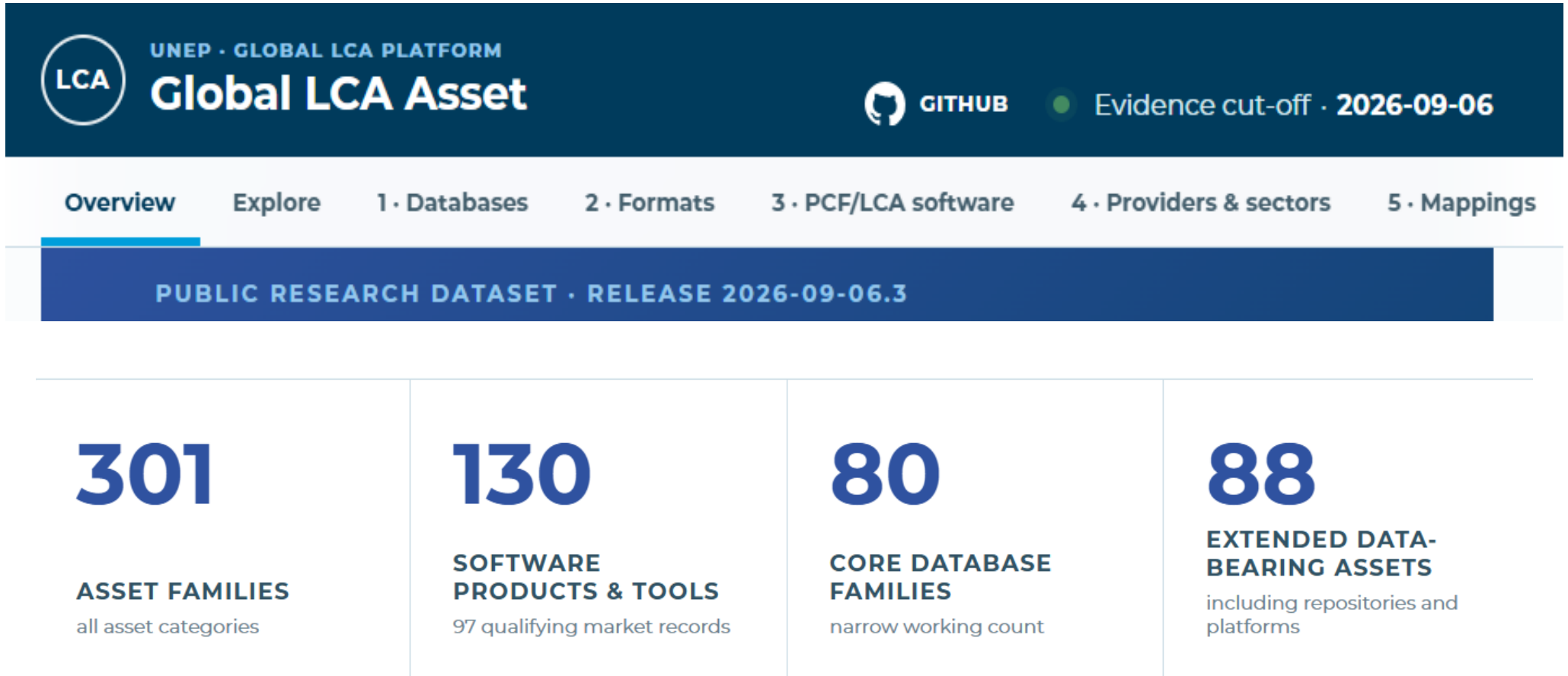


- Global LCA Data Access network (GLAD)
- GLAD mapper tool (Valente et al. 2024)
- EF lists in US data sources (Edelen et al. 2022)
- Lavoisier conversion framework: ILCD – EcoSpold2 (Pilz Savioli et al. 2026)
- ILCD+EPD data format integration with ?BIM and ?DPP (Otero et al. 2026)

+ 12 other sources

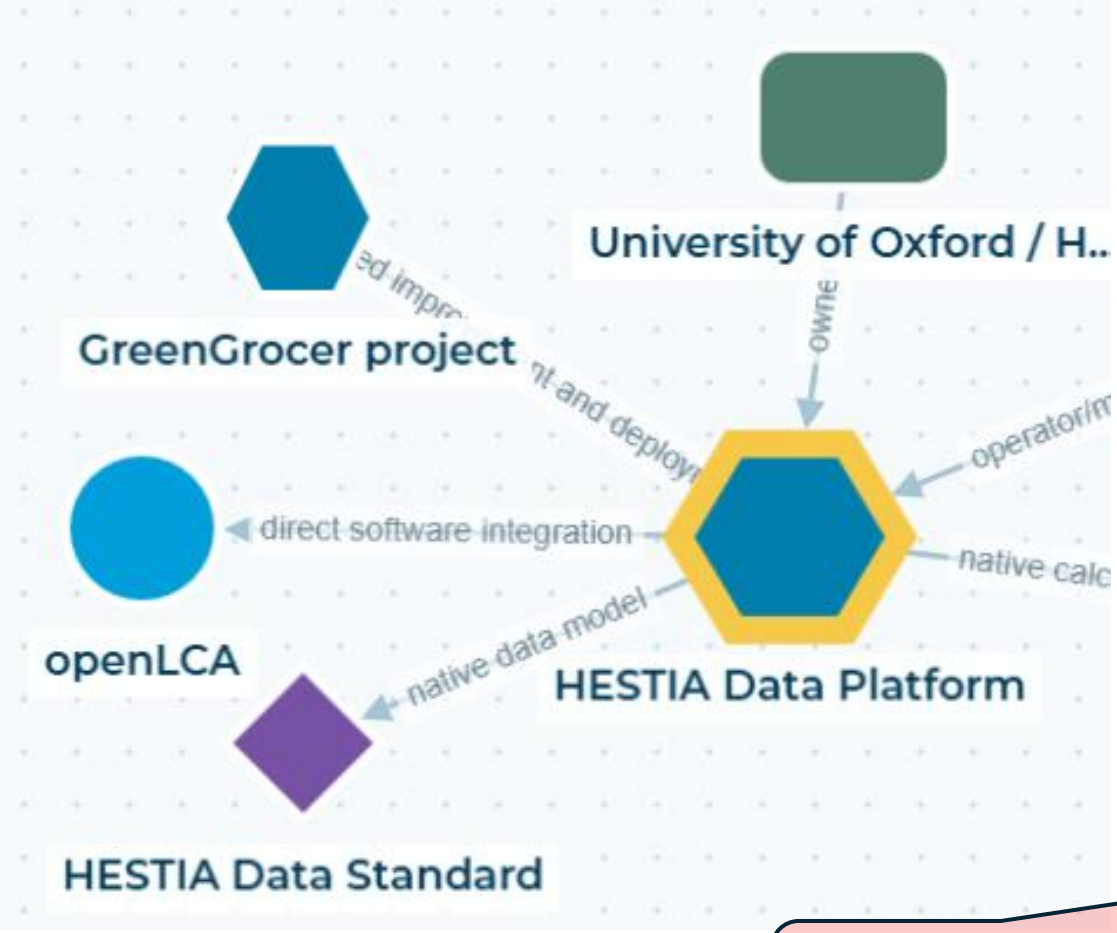
The state of the art is composed of fragmented resources

Global LCA Asset



Life Cycle Initiative (2026). Global LCA Atlas (Blog) (Accessed 14 Sept 2026)

Global LCA Asset



Controlled vocabularies

(7) "asset_type“: [
"Data schema / exchange format",
"Database / dataset", ...],
(186) “relation_type”: [
"native data exchange format",
"native data format",
"background data dependency",
"background-data dependency", ...],
(21) “mapping_type”: [
"Elementary-flow nomenclature mapping",
"Legacy public format converter", ...]
...

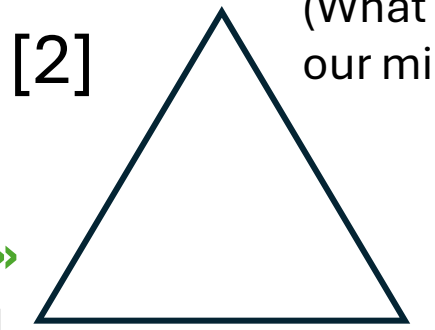
It is not possible to query unstructured natural language deterministically in order to answer questions.

Qi J., Das N., Martins A. (2026). Global LCA Asset (Webapp), (Accessed 14 Sept 2026)

Ontology and semantic

An **ontology** is defined as a conceptual representation of the entities, their properties and relationships in a domain [1].

The semiotic triangle [2]



Concept
(What comes to our mind)

« Jaguar »
Symbol
(The syntax/ language we use)

?
Object
(The real world)









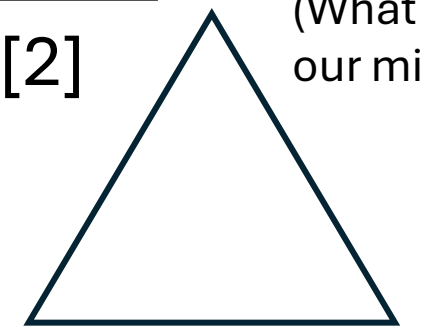


[1] Gruber, T. R. (1993). A translation approach to portable ontology specifications. Knowledge acquisition, 5(2), 199-220.
[2] Ogden, C. K., Richards, I. A., Malinowski, B., & Crookshank, F. G. (1946). The meaning of meaning (pp. 109-38). New York: Harcourt, Brace & World.

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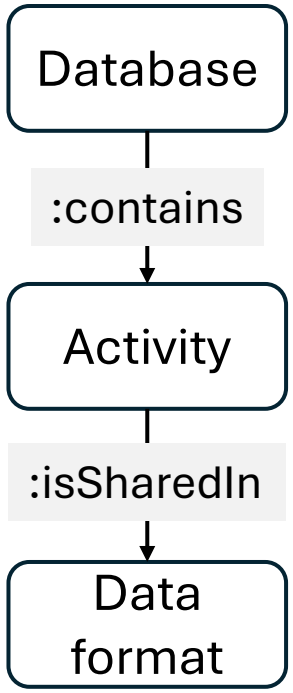
Object
(The real world)

	Bafu.admin.ch	Sphera.com
« electricity, medium voltage »	« Intermediate flows »	« Non-elementary flows »
« Brightway », « SimaPro»	« Software »	« Tool/ modeling software »
« ILCD », « ecoSpold2 »	« Format »	« Data format »

[1] Gruber, T. R. (1993). A translation approach to portable ontology specifications. Knowledge acquisition, 5(2), 199-220.
[2] Ogden, C. K., Richards, I. A., Malinowski, B., & Crookshank, F. G. (1946). The meaning of meaning (pp. 109-38). New York: Harcourt, Brace & World.

Ontologies, semantic databases & queries

T-box (Concepts)



A-box (Assertion of objects)

```
:EcoSpold2    a :DataFormat .

:m_gold       a :Activity ;
              :isSharedIn :EcoSpold2 .

:Ecoinvent39  a :Database ;
              :contains :m_gold .
```

« SQL alike » query

```
SELECT ?database
(COUNT(?activity) AS ?activityCount)
WHERE {

?database a :Database ;
:contains ?activity .

?activity a :Activity ;
:isSharedIn :EcoSpold2 .
}
GROUP BY ?database
ORDER BY DESC(?activityCount)
```

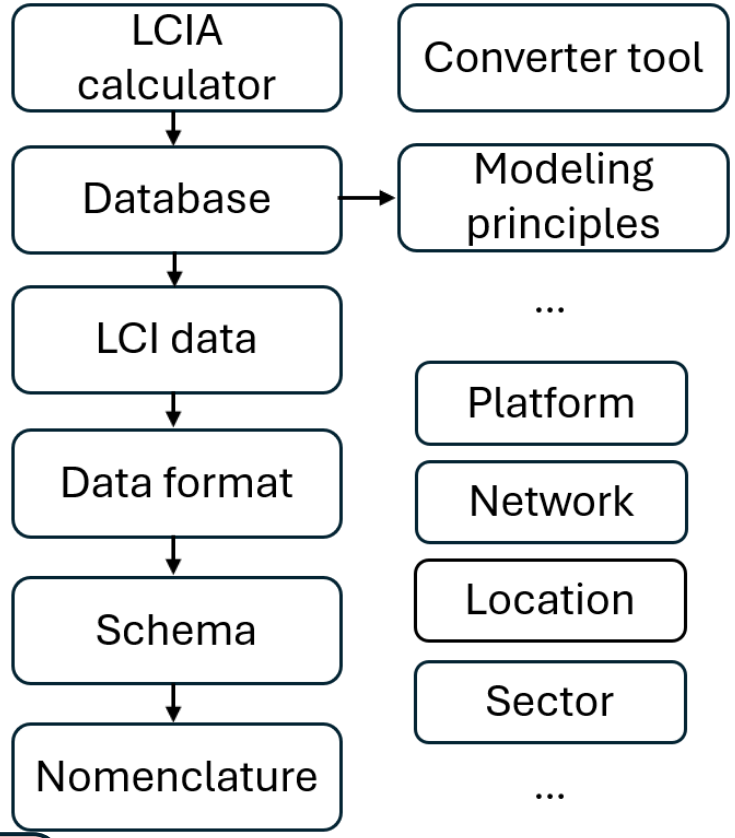
?database	?activityCount
:Ecoinvent39	1

Limitation of the SOTA

Controlled vocabularies

(7) "asset_type“: [
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(21) “mapping_type”: [
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...

→ More expressive ontologies



It is not possible to query unstructured natural language deterministically in order to answer questions.

Qi J. (2026). global-lca-asset (GitHub), (Accessed 14 Sept 2026)

This work

Ontology engineering

Competency questions &
a **shared** conceptualization

Populate the database

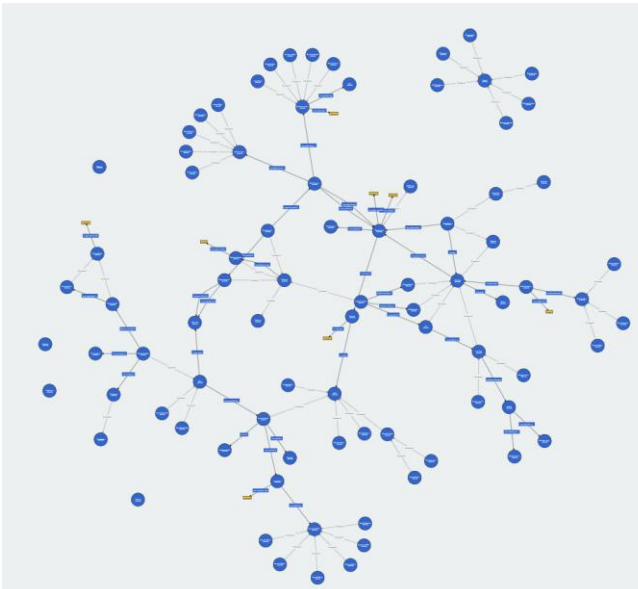
Using a tool for ontology-based
collaborative systematic review

Phase 1

Competency questions (CQ)



Personal conceptualization



Let’s develop this map together

Phase 1

Proof of concept

Phase 2

Development

Phase 3

BrightCon-27

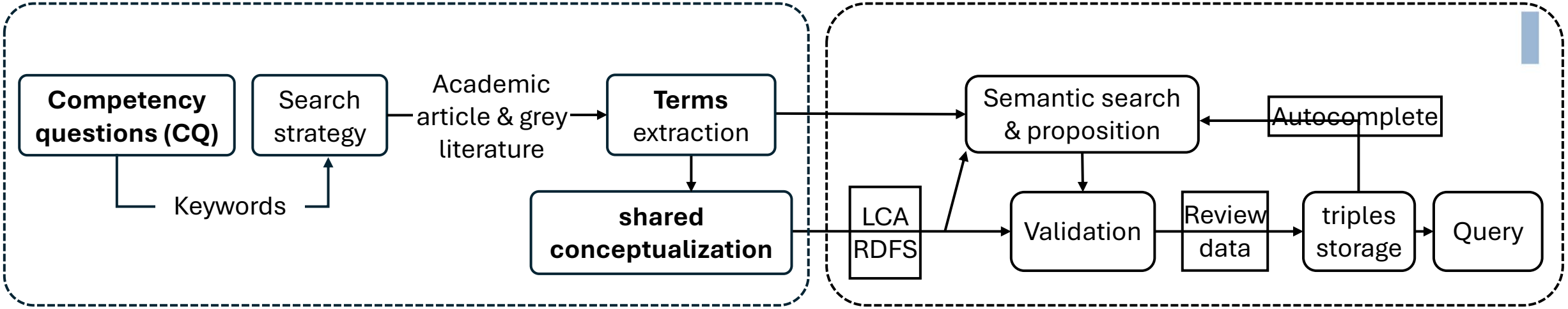
1. How would you like to collaborate ?

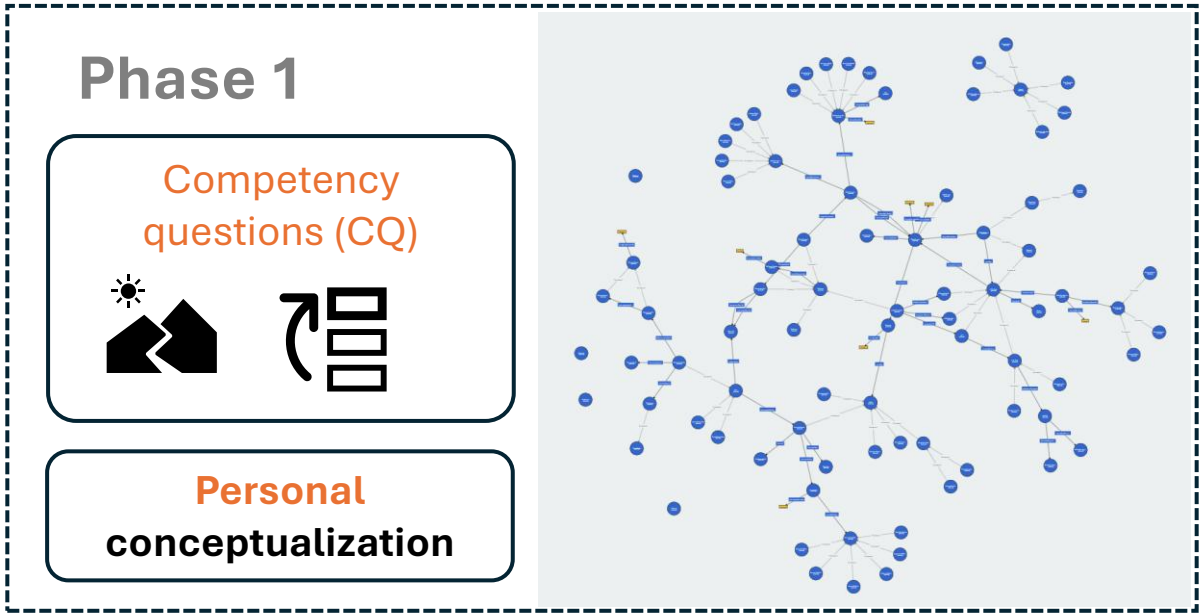
- ○ **Ontology engineering**: Ontology engineering about the interoperability in LCA (**6*2 hours Oct-Dec 2026**)
- ○ **Review tool development**: Graphical interface for ontology-based collaborative system reviews (**Early 2027**)
- ○ **Collaborative review**: Once the tool is ready, I would like to add new sources about my sector (**Brightcon 2027**)
- ○ Other

A Collaborative Systematic Review of LCA data formats: Benefits, Limitations, and Silos

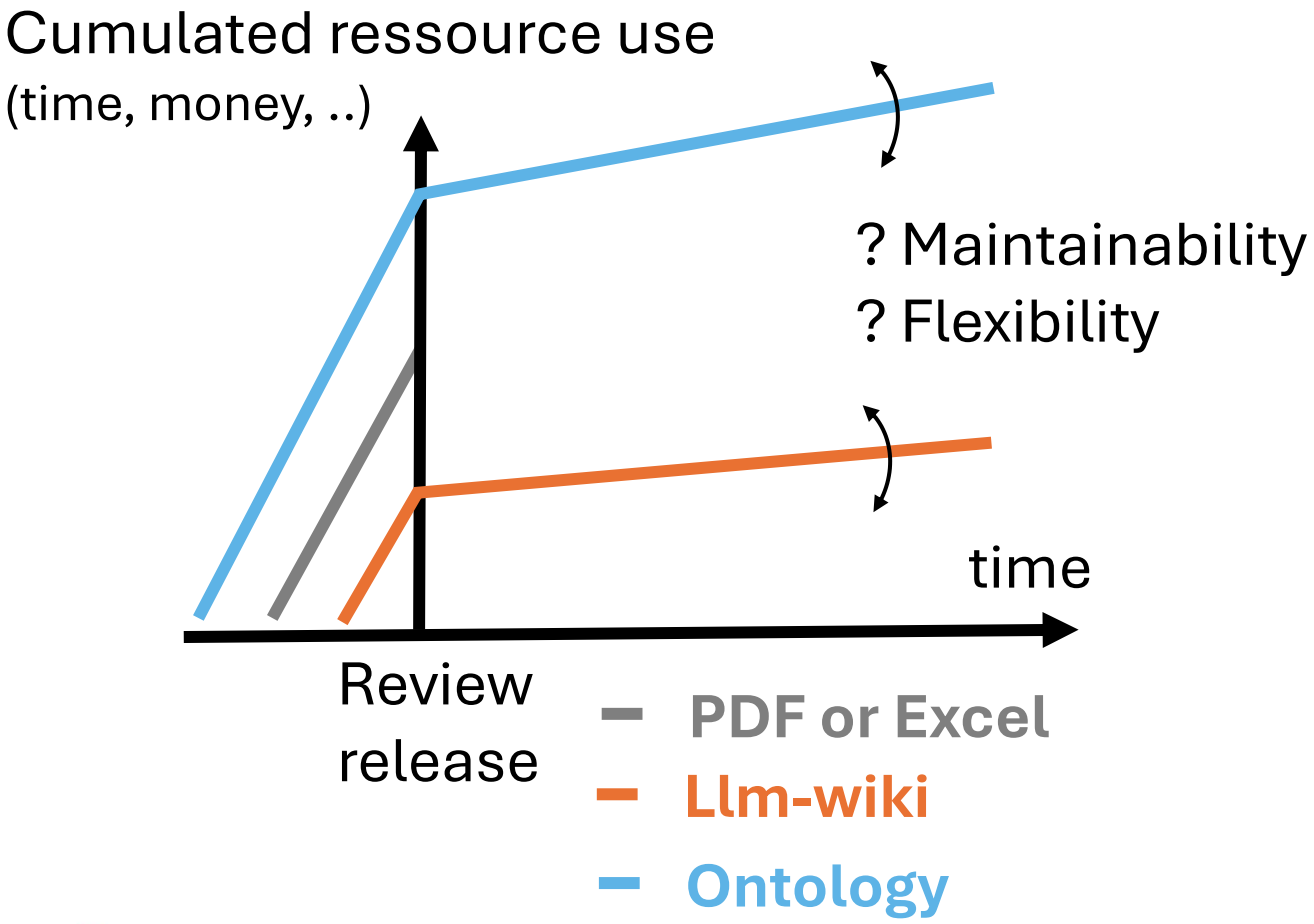
Other slides

This work


Competency questions (CQ)
Search strategy
Keywords
Academic article & grey literature
Terms extraction
shared conceptualization
LCA
RDFS
Semantic search & proposition
Autocomplete
Validation
Review data
triples storage
Query


Phase 1
Competency questions (CQ)
Personal conceptualization

Tools to share reviews



- Avoiding interoperability silo
- Prioritizing software development
- Maximizing the visibility of existing tools
- Showing benefits and limitations of data formats

The availability of tools within the LCA ecosystem is too complex to be assessed comprehensively by a single systematic review.

		LCA	Review	Tool	Interoperability	Sectorial	
		"life cycle assessment" OR "life cycle analysis" OR "life cycle inventory"	"review" OR "overview"	"database" OR "software" OR "tool" OR "data format"	"interoperability" OR “sharing data” OR "data format" OR "schema" OR "serialization"	«ICT » OR « electronic » OR « semiconductor » OR « artificial intelligence »	2010-2027 Scopus results
Existing review/ overview		AND	AND	AND			2869
		AND	AND		AND		103
		AND	AND	AND		AND	260
		AND	AND		AND	AND	29
Studies available for review		AND		AND			15827
		AND			AND		291
		AND		AND		AND	843
		AND			AND	AND	59

Comprehensive reviews that **are** reachable:

- Topic-specific review (e.g., the interoperability in LCA)
- Sector-specific LCA tool review (e.g., the LCA tools in the ICT sector)

16/103 review/overview articles selected on the LCA interoperability

Specific to the construction sector Specific to elementary flows (EF) Data technologies assessment

1. Valente et al. 2024 (EF mapping in GLAD network)
2. Rossi et al. 2026 (A data space-based framework for LCA data sharing) → Propose a framework, interop = requir.
3. Jalaei et al. 2026 (Systematic review of openBIM integration with LCA)
4. Recchioni et al. 2015 (Web-share publication of quality-assured life cycle data via LCDN) → interop = requir.
5. Jia et al. 2026 (Review of data interoperability challenges and advanced methodologies from BIM to LCA)
6. Edelen et al. 2018 (Critical review of Efs in LCA)
7. Turner et al. 2020 (Building ILCD/Ecospold2 compliant data reporting template)
8. Fritter et al. 2020 (Survey of LCI database implementations and architectures)
9. Otero et al. 2026 (Limitations to the digitalisation of EPD with the ILCD+EPD format)
10. Aragon et al. 2025 (Bridging interoperability gap between LCA and BIM)
11. Bolognesi et al. 2025 (Overview of LCA integration in BIM)
12. Teng et al. 2022 (Systematic review of BIM intergration with LCA)
13. Tang et al. 2026 (Automated extraction and retrieval of LCA data with LLM) → not a relevant interop. review
14. Quernheim et al. 2026 (Data space for sustainable product development)
15. Steiner et al. 2026 (Standardized LCA data exchange in the aviation supply chain)

Full Sources

Title	Year	Authors
Towards a Sustainable Aerospace Industry: A Concept for a Standardized Life Cycle Assessment Data Exchange in the Aviation Supply Chain	2026	Steiner J.; Töpfer N.; Klumski J.; Riedelsheimer T.; Lindow K.
Data Spaces for Sustainable Product Development –A Structured Analysis of Technical and Semantic Infrastructures	2026	Quernheim N.; Scheerer H.; Hesse A.; Winter S.; van der Valk H.; Otto B.; Schleich B.
From literature to knowledge graphs: automated extraction and retrieval of life cycle assessment data with large language models	2026	Tang Z.; Dreger M.; Jiang P.; Malek K.; Tu Q.
A systematic review of the integration of building information modeling into life cycle assessment	2022	Teng Y.; Xu J.; Pan W.; Zhang Y.
An Overview on LCA Integration in BIM: Tools, Applications, and Future Trends	2025	Bolognesi C.; Bassorizzi D.; Balin S.; Manfredi V.
Bridging Interoperability Gaps Between LCA and BIM: Analysis of Limitations for the Integration of EPD Data in IFC	2025	Aragón A.; Spudys P.; Pupeikis D.; Nieto Ó.; Garcia Alberti M.
Limitations to the digitalisation of EPD used for the assessment of sustainability using ILCD+EPD format	2026	Otero S.; Aragón A.; Nieto Ó.; Conde M.; Tenorio J.A.
A survey of Life Cycle Inventory database implementations and architectures, and recommendations for new database initiatives	2020	Fritter M.; Lawrence R.; Marcolin B.; Pelletier N.
Building an ILCD/EcoSPOLD2–compliant data-reporting template with application to Canadian agri-food LCI data	2020	Turner I.; Smart A.; Adams E.; Pelletier N.
Critical review of elementary flows in LCA data	2018	Edelen A.; Ingwersen W.W.; Rodríguez C.; Alvarenga R.A.F.; de Almeida A.R.; Wernet G.
Bridging the Semantic Gap: A Review of Data Interoperability Challenges and Advanced Methodologies from BIM to LCA	2026	Jia Y.; Zhang P.; Liu Q.
Impacts of life cycle inventory databases on life cycle assessments: A review by means of a drivetrain case study	2020	Kalverkamp M.; Helmers E.; Pehlken A.
Challenges and opportunities for web-shared publication of quality-assured life cycle data: the contributions of the Life Cycle Data Network	2015	Recchioni M.; Blengini G.A.; Fazio S.; Mathieux F.; Pennington D.
Integrating OpenBIM and LCA for Sustainable Construction: A Systematic Review and Proposed Research Framework	2026	Jalaei F.; Jrade A.; Rostamiasl V.; Jalaei F.; Jalilzadeh Eirdmousa S.; Rostaminikoo R.; Hosseini Gourabpasi A.
Digital Transformation: A Data Space-based Framework for Life Cycle Assessment Data Sharing	2026	Rossi L.; Marra E.; Capuzzimati C.; Chaves A.C.; Baptista A.; Menato S.
Elementary flow mapping across life cycle inventory data systems: A case study for data interoperability under the Global Life Cycle Assessment Data Access (GLAD) initiative	2024	Valente A.; Vadenbo C.; Fazio S.; Shobatake K.; Edelen A.; Sonderegger T.; Karkour S.; Kusche O.; Diaconu E.; Ingwersen W.W.
Can LCA be FAIR? Assessing the status quo and opportunities for FAIR data sharing	2024	Ghose A.
Bridging the interoperability gap in life cycle assessment: the lavoisier conversion framework and implementation for EcoSpold 2 and ILCD formats	2026	Pilz Savioli, J. P. P. D. D., Braga, T. E. N., Rodrigues, T. O., Vidotti, S. A. B. G., & Ugaya, C. M. L.